Investigation

BLOWING IN THE WIND

Background Information

Air quality is measured by more than a thousand locations across the country each day. This information from these monitoring stations is converted into an **Air Quality Index** for each of the individual pollutants in an area (carbon monoxide, ground-level ozone, nitrogen dioxide, sulfur dioxide, lead, and particulate matter).

Areas that do not meet the standards face consequences such as loss of federal highway funds, stricter permitting rules for industry, and stricter emissions tests for motor vehicles.

Air-quality is measured in two ways: emissions and ambient levels. Emissions are an estimate of the amount of pollution caused by man-made activities. Ambient levels are the concentration of a pollutant in the air. **National ambient air quality standards** are set by the federal government and monitored by state agencies.

Topography, meteorology, and concentration of pollution emissions are taken into consideration when determining the location for air-quality monitoring sites. Prevailing weather conditions and local topography will strongly influence the dispersion of air pollutants or, in the case of secondary pollutants, affect their production in the atmosphere. The source of pollution varies, requiring multiple monitoring sites in a given **airshed** necessary.

Pollutants in the air are individually identified using a variety of complex techniques. Pollution that leads to ozone formation can be divided into two categories, nitrogen oxides and volatile organic compounds. Volatile organic compounds are measured using **gas chromatograph**.

How a gas chromatograph works. In a gas chromatograph, a sample of the mixture to be analyzed is injected into a stream of inert gas (e.g., helium) flowing through a long column. The column is coiled inside a temperature-controlled oven. The carrier gas moves different chemicals through the column at different rates, the fastest exiting first. As each compound exits the column, the chromatograph's detector plots the size of the electrical signal it generates against the amount of time it spent in the column. The resulting graph (chromatogram) shows what was in the original sample.

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The National Ambient Air Quality Standards

POLLUTANT	STANDARD VALUE
Carbon monoxide (CO)	
8-hour average	9 ppm
Ozone (O_3)	
1-hour average	0.01 ppm
Nitrogen dioxide (NO_2)	
Annual arithmetic mean	0.053 ppm
Sulfur dioxide (SO_2)	
Annual arithmetic mean	0.03 ppm
Lead (Pb)	
Quarterly average	1.5 µg/m3
Particulates <10 micrometers	
Annual arithmetic mean	50 µg/m3

This is a partial list of National Ambient Air Quality Standards. A complete list can be found on the U.S. Environmental Protection Agency's web site at **http://www.epa.gov/airs/criteria.html** .

To simulate this process, you will evaluate a simulated air sample mixture and evaluate its different components. The model will simulate the components of a sample of air, including normal gases such as nitrogen, oxygen and water vapor, as well as pollutants such as ozone, sulfur dioxide, carbon monoxide, nitrogen oxides, lead and particulate matter.

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Problem: *(fill in problem):* ______________________________

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Materials

Air Samples (Provided by the teacher)*
Map pencils
Maps showing location of monitoring station

**Collect air monitoring data from the Texas Commission on Environmental Quality www.tceq.state.tx.us. Choose data from different days for each lab group. Give each group data collected at 6:00 am, 12:00pm, and 6:00pm .*

Let data collected for each time of day be represented by colored spots made with a hole punch and construction paper. The values per spot for ozone and sulfur dioxide is .001 ppm; nitrogen dioxide and carbon monoxide is 0.1 ppm; lead is 0.1 μg/m^3 and particulate matter is 1.0 μg/m^3 . Place spots in plastic bags, which are labeled with the monitoring station location and the time of day.

Procedure

1. Label the data table with the name of the monitoring station and collection time found on the "air samples" bag.
2. Open the "air sample" and separate the spots into groups by color.
3. Count the number of spots (pollutants) of each color and record that number on the data table.
4. Calculate and record the value of each pollutant. Let each spot represent .001 ppm for ozone, and sulfur dioxide. Let each spot represent 0.1 ppm for carbon monoxide and nitrogen dioxide . Let each spot represent 0.1 μg/m3 for lead and 1.0 μg/m3 for particulate matter.

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Observations

Monitoring Station ______________________________

Trial	Time	Color	Representing Component	No. of spots	Value in ppm	Value in µg/m3
1		orange	carbon dioxide			NA
2						NA
3						NA
1		red	ozone			NA
2						NA
3						NA
1		purple	nitrogen dioxide			NA
2						NA
3						NA
1		yellow	sulfur oxides			NA
2						NA
3						NA
1		black	lead		NA	
2					NA	
3					NA	
1		brown	particulate matter		NA	
2					NA	
3					NA	

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Create two graphs, one for lead and particulate matter ant the other for the remaining pollutants. Make sure you title each graph, label the axes with the units of measure, and create a color key.

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Conclusion

1. Using the NAAQS level table in the background information, determine if any of the components in the "air" samples taken are above acceptable levels.

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2. What is the significance of the time of day in air sampling? ____________________

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3. What are the shortcomings of this simulation? ____________________

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4. How could the simulation be improved? ____________________

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Application

1. Based on what you know from reading about how ozone forms, during what season would you expect ozone levels to peak?____________________

2. How does rain affect ozone formation?____________________

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3. Our air knows no boundaries. Wind can carry pollutants hundreds of miles from their origin. The distance air pollutants travel depends on how high in the atmosphere they go. Why does this present a problem?

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4. The Texas Natural Resource Conservation Commission consistently monitors air quality at approximately 150 stations across Texas. Why is it important to monitor so many locations?

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Going Further

5. Air at ground level is usually warmer than air at higher altitudes. This is due to the difference in atmospheric pressure. There is less pressure at higher altitudes, so the molecules in the air can spread out. They collide less often and produce less heat. When a temperature inversion occurs, this process is disrupted. A layer of warm air becomes sandwiched between layers of cooler air above and below because of differences in the density of the layers. Temperature inversions can form near the ground or at heights of hundreds or thousands of feet. In either case, the cooler, denser air layer at the surface is held in place by the warmer, less dense air above.

   How would a temperature inversion affect air pollution in an area? ____________________

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6. Geographical conditions or topography affect ozone formation. Mountains, valleys, and bodies of water affect ozone's ability to dissipate or settle. Geographical proximity to sources of pollutants affect level of air pollutants. Collect information and study maps of the area surrounding your monitoring station to determine what geographical conditions play a role in the level of air pollutants found at your monitoring station.

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